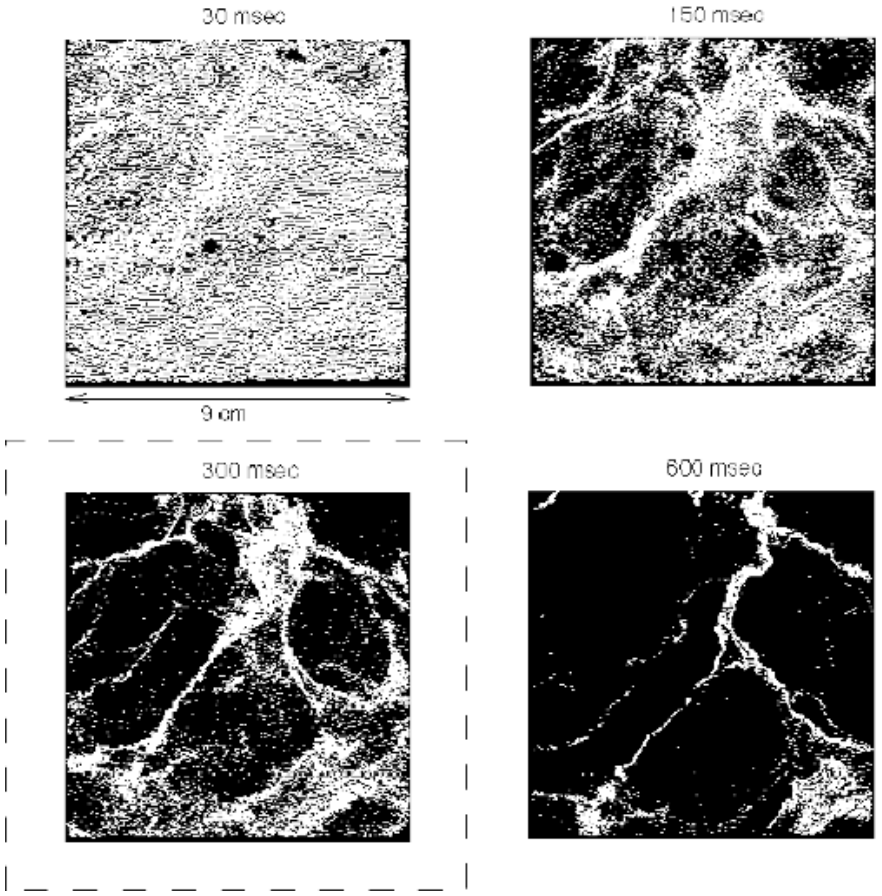
Compressible Turbulence, University of Pittsburgh DMR-0201805

If a spot of dye is added to a clear, turbulent fluid, it will be rapidly dispersed throughout its volume, as one observes by stirring cream into coffee. Once complete mixing has occurred, further stirring will do nothing; the dye concentration will remain uniform.

Compare that with the photographs to the right. There the "dye" particles are ones that float on the surface of a tank filled with turbulent water. Surprisingly, floaters that are initially spread uniformly on the surface, collect into globs and strings, as one observes. Note that the coagulation is almost complete in less than a second. This effect is studied in detail, and the results are compared with current theoretical ideas. This coagulation effect should play a role in dealing with pollution at the ocean's surface and in the propagation of phytoplankton that live there.



The coagulation seen in the above figure is intimately connected with compressibility. Water is incompressible, but in a turbulent fluid, it can give rise to momentary jets flowing upward and downward. Consider what happens near the surface at a point where water in the interior of the fluid is moving downward. Floating particles cannot follow, since they are confined to the surface. Instead, they accumulate at such points. Similarly, upward jets drive particles away. That is just what the photo shows. Since the flow is fluctuating, the points of accumulation and clustering shift about in time and in space. In roughly 1 sec after the particles are uniformly dusted on the surface, they have all fled to the edge of the tank, where they stick. A photograph will then show a uniformly dark field. The compressibility effect seen here is also produced by heavy particles inside a turbulent flow. Here it is their inertia that causes them to momenarily accumulate at some points.

Turbulence in a Free Surface W. I. Goldburg
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Education:

Two graduate students, Andrew McQuiston and Mahesh Bandi, and two undergraduate women. Dr. J. R. Cressman, a former student who worked on this project, is now investigating brain function and epilepsy at George Mason University. The techniques of dynamical systems theory, which he learned while working on his PhD, are serving him well in his present research field. Turbulence is a good launching point for entrance into many careers outside of physics.

Outreach:

Over the years, this laboratory has trained many minority and undergraduate students, some of whom have gone on to research careers in and out of physics. As an officer of the American Physical Society's Topical Group on Statistical and Nonlinear Physics, I have been working on the development of a website concerned with chaos, the target audience being students in grades 6-12. The topic of Chaos has aesthetic as well as scientific appeal; images of chaotic behavior often are pleasing to the eye as well as stimulating to the mind.